McKinsey Study. A study completed by McKinsey & Company during mid-1995 on behalf of the U.S. Advisory Council on the National Information Infrastructure estimated the costs of accessing the NII by network element and also by deployment option. McKinsey determined that the largest up-front cost would involve the purchase and installation of hardware, while teacher training and support would account for most of the ongoing deployment cost. Connection costs would be a relatively small proportion (four to 15 percent) of either initial or recurring expenditures, regardless of the deployment plan.[11] McKinsey presented four deployment "models," each of which would include a district server and local area network; one or more school servers, printers, and scanners; software, professional development, and support.[12] The results of the four models are described briefly below:

The Lab Model resulted in estimates for initial deployment ranging from $11 billion for a 25-computer lab using an Ethernet LAN and ten telephone lines. Annual operations and maintenance expenditures were estimated at $4 billion per year.

The Lab Plus Model added a computer and modem for the teacher to the Lab model, resulting in estimated costs of $22 billion in up-front expenditures. Annual operations and maintenance were estimated at $7 billion per year.

The Partial Classroom Model would provide one-half of all classrooms with one computer per five students, an Ethernet LAN across and within all classrooms, and a T-1 connection at a cost of $29 billion. Annual operations and maintenance expenditures were estimated at $8 billion over a five-year period.

The Classroom Model resulted in estimates of $47 billion to connect every public school classroom to the NII during a ten-year interval, assuming five students per computer, with a T-1 communications channel that transmits data, video, and voice at 1.5 Mbps. Annual operations and maintenance expenditures

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11/ U.S. Advisory Council on the National Information Infrastructure, KickStart Initiative: Connecting America's Communities to the Information Superhighway, 90-91 (Jan. 1996).

12/ McKinsey notes that the ED/MIT studies "informed [their] approach early on" but the Rothstein/McKnight analysis factored in less training and support, much longer hardware replacement cycles, and no packaged software or upgrades, and did not allow for either declining hardware prices over time or differing rural/urban connection requirements. McKinsey & Company, Connecting K-12 Schools to the Information Superhighway 63-64 (1995) [hereinafter McKinsey Study].

were estimated at $10 billion during a ten year period.[13] McKinsey concluded that this model most closely meets the Administration's vision of connecting every classroom to the NII.

B. Public Libraries

As with schools, the data from these studies go beyond the connection portion that might be funded under the Snowe-Rockefeller amendment to the Act. Realizing that the subsidies would apply to interconnection costs, it is nevertheless useful to examine broader cost data and gain some perspective on total costs for bringing the NII to the public libraries.[14]

In reviewing the results of the studies, it is important to realize that rural libraries have special needs attributable to their relative remoteness. In New York State's "Project GAIN" initiative, researchers determined that a "reasonable" start-up cost for basic computing equipment, connections, and support (including training) for a rural library was $8,000 to $10,000.[15] Long distance calling -- a necessity for many rural libraries because there is often no nearby interexchange carrier "point-of-presence" -- can average $175-350 per month (without preferential rates).[16] A 1995 study sponsored by the National Commission on Libraries and Information Science (NCLIS) reached similar conclusions. This study, which was performed by McClure, Bertot, and Beachboard, estimated that a rural library using a single work station and text-only access could achieve a minimal level of Internet connectivity for $1,475 in one-time costs and $12,635 in annual recurring costs. Telephone toll charges and Internet provider connection and usage

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13/ Kickstart Initiative, supra note 11 at 92-95. McKinsey also considered a Desktop model that would place a networked PC on each student's desk, but the consultant abandoned an in-depth examination because of the perceived high costs of implementation. For example, initial installation costs were estimated to be 3.5 times greater, and ongoing costs 2.5 times greater, than the figures calculated for the Classroom model. McKinsey Study, at 24.

14/ While the studies discussed present a mix of per-institution and aggregate library costs, the insights provided tend to outweigh any incongruities.

15/ Hearings on Internet Access Before the Subcomm. on Science of the House Comm. of Science Space and Technology, 103rd Cong., 2nd Sess. 8 (1994) (statement of Charles R. McClure, School of Information Studies, Syracuse Univ.); see also NYSERNet, The Project GAIN Report: Connecting Rural Public Libraries to the Internet 8 (Feb. 15, 1994).

16/ NYSERNet at 29.

fees would account for more than 80 percent of the total outlays for one-time and annual recurring costs, taken together.[17] Thus, a first-year expenditure on a single-work-station, text-based Internet access for a rural library would average less than $15,000.

If telephone toll charges -- the biggest ongoing cost factor identified in rural environs -- are largely removed from the calculation, the corresponding expenditure for a city library could be less than $10,000, on average.[18] Accommodating five simultaneous users (i.e., five terminals) in a city library, however, would increase the required first-year outlay to an average of $42,290 -- $13,040 in one-time costs and $29,250 in annual recurring costs for basic Internet access.[19] For a single workstation in a single urban library with multimedia capabilities, the first-year cost for Internet access capability would be $6,570, including $4,615 for one-time costs and $1,955 for annual recurring charges.[20] A more complex and sophisticated level -- adding multimedia capabilities at multiple work stations at a main city library with four branches and much more network management -- would raise costs to an estimated $434,595 for Internet access and $568,495 if Internet service provision is included.[21]

McKinsey developed cost estimates for public libraries on the basis of a scenario assuming the deployment of 25 networked computers with ten simultaneous users and a local area network. The analysis divided libraries into two general categories based on type of connection. Under the selected scenario, those serving populations of more than 25,000 would use T-1 (1.5 Mbps) lines, while the smaller libraries split 60-40% between ISDN (56 to 128 Kbps) and POTS (14.4 to 34 Kbps). Initial deployment costs to connect libraries to the NII -- including hardware, software, training and support, connections, and system integration -- were estimated at $1.6 billion, while ongoing costs -- using the same categories as initial deployment plus content/resource development -- were estimated as exceeding $1.3 billion per year. Similar to the schools, connections to the NII for libraries would constitute a relatively low proportion of total costs: four percent of initial deployment and nine percent of on-going costs, with another

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17/ Charles R. McClure, John Carlo Bertot, and John C. Beachboard, National Commission on Libraries and Information Science, Internet Costs and Cost Models for Public Libraries, Final Report at 15, Figure 6 (June 1995).

18/ Id.

19/ Id. at 15-16, Figure 10.

20/ Id. at 15, Figure 8.

21/ Id. at 19, Figure 14.

23 percent of annually recurring costs disbursed mainly for information services.[22]

III. Cost Data from Some TIIAP Grants

Examination of three illustrative school projects funded through NTIA's TIIAP program sheds light on real-life cost experiences. As with the presentation of data from the studies discussed above, while we recognize that the Snowe-Rockefeller amendment applies only to the connection portion of costs, we present the data in the broad context of costs for accessing and using services offered over the NII. Examples from regional, inner city, and rural cases, respectively, are as follows:

Rockbridge Project, located in Lexington, Virginia, involves a regional grant to 17 K-12 schools that includes a central computer, routers, and a multi-media workstation for each school, as well as Internet access through a Wide Area Network (WAN), training, and maintenance. Hardware represents the largest one-time cost element (65.0%, $144,040), followed by maintenance (18.9%, $41,820) and communications (9.5%, $21,139). Among annual costs, communications represents the largest component (63.9%, $58,824). More specifically, an Internet service provider (ISP) will provide both 56 Kbps service at $1,000 setup plus $350 per month, and T-1 service at $2,400 plus $1,400 per month. Connections from the ISP to each central site include standard ($120 setup and $28 per month) and foreign exchange ($120 plus $140 per month) dialup; 56 Kbps local ($443 and $156 per month) and inter-office ($450 plus $250 per month) lines; and frame relay to the ISP, both 56 Kbps ($1,305 and $363 per month) and T-1 ($2,110 and $897 per month). Besides Internet access, these connections permit store-and-forward e-mail, network news discussion groups, and information access to the World Wide Web, Gopher, and File Transfer Protocol (FTP) services. Electronic document delivery and dialup ports for home access are other capabilities.

Harlem Environmental Access Project (HEAP), an inner city setting in New York City, received a TIIAP grant for six schools. Based on the average estimated cost per school, hardware ranked first (60.6%, $10,266), followed by training (21.7%, $3,666) and connection (17.7%, $3,000). Connection also contributes $5,600 annually to expenses. Each school received four computers and printers, a T-1 line, Internet access, and training. Through this connection, Columbia University and the Environmental Defense Fund are collaborating with local schools to bring computer equipment and infrastructure, Internet access, technology

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22/ KickStart Initiative, supra note 11 at 94-98.

assistance, and environmental information and curriculum development to an underserved community in a New York City Empowerment Zone.

Green Valley High School, a rural suburb of Las Vegas, received matching grants to install three computers, a fiber optic backbone and related cabling to three classrooms, a T-1 link, teacher training, and technical maintenance and support. Total up-front costs equaled $85,500, of which connections (installation, switching, and service) accounted for 58.3% ($50,000). Connections incurred $9,840 in annual recurring costs. Initially, the T-1 line cost was $795 per month, but as the number of computers increases by 75, the link costs will rise to $1875-2000 per month. Services subscribed to include Internet access and "unlimited use" for $25 per month.

IV. General Implications of the Cost Data

The limited data available on the cost of bringing the NII to schools and libraries provides a starting point for determining the potential connection costs for these institutions and, more specifically, the extent of any subsidy that might occur pursuant to the Snowe-Rockefeller provision of the Act. Accordingly, we must stress that the following implications are meant to commence a dialogue rather than serve as final conclusions on the cost issue.

Under McKinsey's assumption of a relatively high-end deployment, such as wideband (T-1) capability, connectivity to virtually all classrooms, and one computer for every five students as the norm, the total costs for connecting schools would be an estimated $109 billion for connections, hardware, software, training, and support over a ten-year time period. This would translate into about $11 billion per year.[23/] Under a scenario with less support and training, a somewhat higher ratio of students (eight) per computer, longer hardware replacement cycles, and no packaged software or upgrades (as in Rothstein's Model 4), the total cost over a five-year span falls into a range: the low end may reach $20 billion, or $4 billion per year, and the high could approach $50 billion, or $10 billion per year. For libraries, assuming a Lab scenario (i.e., single-room deployment, 25 computers, ten simultaneous users), the McKinsey study projected

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23/ Gauged by another measure, implementing the above scenario would require an expenditure of an estimated four to five percent of the budget for K-12 public schools in the peak (tenth) year -- compared to the current proportion of 1.3 percent. Id. at 90. For Rothstein's Model 4, with eight students per computer and 56 Kbps connection to a school district office with a T-1 link over a five-year period, the percentage would be three to seven percent of national educational expenditures. MIT Thesis, supra note 4 at 49.

a much lower total outlay: initial deployment at $1.6 billion, with $1.3 billion in annual recurring costs, or apparently less than $10 billion over five years, or less than $2 billion per year. The cost of connections -- including up-front and recurring costs -- appears to be a relatively small proportion of the overall cost, on average, for K-12 schools with all classrooms linked to the NII, perhaps on the order of ten percent of the total described above.[24]

The resulting costs for public libraries is less clear from the analyses but point to moderate albeit somewhat higher percentages with respect to connection costs than for the schools. In one study, for libraries providing World Wide Web services and supporting multiple, multimedia workstations with Internet access at T-1 speeds, "communications hardware and fees" accounted for about eight percent of one-time costs and 29 percent of ongoing costs, or roughly 20 percent of total deployment costs.[25] A second analysis would appear to yield results that are not dissimilar: a small up-front cost of four percent for T-1, ISDN, or POTS connections, but ongoing costs of nine percent for connectivity plus 23 percent for primarily information services ("content").[26]

The differing percentages between schools and libraries may reflect several factors. One plausible explanation may be the much greater volume of hardware (e.g., PCs) needed to equip all the classrooms at a given school relative to a typical library. The libraries' figure may also reflect the cost of additional educational

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24/ For example, McKinsey estimated such costs under the Classroom scenario to be four percent of all initial deployment costs and seven percent of all recurring costs. KickStart Initiative, supra note 11 at 90-91. McKinsey cautioned, however, that usage costs could go up over time, and that one strategy to mitigate this effect would be to install greater-capacity connections up front. Id. at 92. Rothstein estimated that costs for telecommunications lines and services would account for 11 percent of the total costs of networking schools, which is "...lower than the costs assumed by much of the technology community, including the telecommunications service and equipment providers." R.I. Rothstein, *Connecting K-12 Schools to the NII: A Preliminary Assessment of Technology Models and Their Associated Costs*, Technical Horizons in Education Journal 2 (Oct. 1995).

25/ See Comments of the American Library Association, CC Docket No. 96-45 at 14 (April 10, 1996) citing NCLIS, Internet Costs and Cost Models for Public Libraries, Final Report (June 1995). The 20 percent figure is not provided in the NCLIS report, but represents a very approximate averaging of one-time and ongoing costs (where the weighting for the recurring costs increases as more years are assumed, resulting in a communications/total cost percentage of, e.g., 17.2 percent for one year, 24.9 percent for five years).

26/ KickStart Initiative, supra note 11 at 96-98.

software and subscription to on-line services. An important factor potentially influencing the magnitude of the cost for a given institution (besides hardware, software, technical support, and training) could be the type of service required to reach the serving long-distance carrier's "point-of-presence" (POP) for Internet access. For many rural libraries and schools, this would require long-distance calling, which may be difficult to control.[27/]

Thus, the estimates derived from the data reviewed above afford -- at best -- a rough estimate of the average annual costs that could be incurred for connecting and sustaining schools' and libraries' use of the NII. If the per-annum cost of deployment for public schools were roughly $4-11 billion, and for public libraries $2 billion, the aggregated figure would be roughly $6-13 billion.[28/] If the connectivity percentage were estimated at ten percent for schools and 20 percent for libraries -- admittedly very tentative figures based on the limited data available -- the annual aggregated amount for connections would be roughly $.8-1.5 billion. Any provision of discounted services under the Snowe-Rockefeller provision would reduce the latter figure by the extent of any subsidy from the appropriate universal service mechanism. The impact of the Act's provision according discounts for schools and libraries under Section 254(h)(1) will depend on the actual network configurations selected by those institutions.

Again, the data from the models reviewed serves only as a starting point for exploring this issue. The above-mentioned TIIAP grants help illustrate the variability of an institution's telecommunications outlays or "connection" costs as a proportion of total expenditures needed for access to the NII. In the case of rural Green Valley High School, communications expenses ranked first in both up-front costs and annual recurring costs. On the other hand, up-front connections or communications registered the lowest ranking for both Harlem, an inner city

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27/ For documented problems of controlling such "variable" costs in households, see, e.g., Lyndon B. Johnson School of Public Affairs, The University of Texas, The Evolution of Universal Service Policy in Texas (1995); and Milton Mueller and Jorge Schement, Rutgers University School of Communication, Universal Service From the Bottom up: A Profile of Telecommunications Access in Camden, New Jersey (1995).

28/ It should be kept in mind that this broad estimate represents a calculation based on models, not a detailed inventory of every school and library. In practice, existing stocks of networking equipment or software, or levels of training and support, could differ from those assumed in the models, and actual deployment could differ from institution to institution as a result of varying needs and budgets. More importantly, a public-private sector partnership has already begun building the infrastructure of schools and libraries at nominal charges or for free through, for example, contributions of new or surplus PCs or software, or training or support.

school, and Rockbridge, a regional cluster of schools. In Harlem and Rockbridge -- similar to Green Valley -- annual connections or communications disbursements ranked number one among recurring-cost categories, but the amounts per school ranged from less than $1000 (Harlem) to more than $9,800 (Green Valley) for varying capabilities. In each case, networking centered in a lab or media room -- in lieu of connectivity for all classrooms -- tended to reduce hardware, training, and support costs for both one-time and recurring expenditures relative to more extensive networking systems.

V. Specific Implications for the Snowe-Rockefeller Amendment

Importantly, "connections" represents the portion of the NII costs for schools and libraries that come under the Snowe-Rockefeller amendment to the Act, permitting these institutions to obtain, upon bona fide request, FCC-authorized "special services" to be used for "educational purposes" at rates less than the amounts charged for similar services to other parties. If the costs are relatively small, the burden to fund the discounts may not be substantial; if relatively high, however, a significant contribution to the fund may be required.

In view of the above data, the connections portion of total deployment costs would seem to be relatively low for libraries and schools. The discounted connections services which may draw support from the universal service mechanism would tend to represent only a fraction of the expenditures incurred by the schools and libraries. Based on the foregoing data, implementation of the preferential rate scheme in the Act is likely to cost significantly less than achieving the remainder of the task of connecting and sustaining schools and libraries -- obtaining and deploying hardware, software, training, and technical support.

Thus, the demands placed on the new universal service mechanism may be a relatively modest proportion of the total costs of bringing schools and libraries into the Information Age. The specific outlays relating to telecommunications will vary according to the needs of a given institution but, generally speaking, will be of a much lesser magnitude than those for PCs, technical support, and training where all classrooms are connected to the NII. Exceptions may occur where network usage rises relative to up-front costs, and rapid technological change could put pressure on institutions to upgrade their hardware and associated training and technical support. For schools or libraries in rural, often higher-cost or lower-income areas, outlays may be higher because of the greater need for long-distance calling in order to reach the Internet or other destinations, or perhaps due to requirements for substantially longer local loops.

In conclusion, the goal of connecting and sustaining access for schools and libraries to the NII requires the integration of a number of elements. Preferential

rates under the Snowe-Rockefeller amendment to the Act represent only one ingredient -- albeit an important one -- in the mix. Other key elements include computers, educational software, trainers and training programs, and support such as maintenance and repair. A critical part of the process will be for those in the educational community to integrate the information afforded by the NII into a meaningful curriculum for students. Library administrators can also contribute to this goal by providing user-friendly capabilities and technical assistance to those using their facilities.

Thus, the Act's preferential rate scheme for schools and libraries is an important linchpin for full realization of the benefits offered by the NII. The Snowe-Rockefeller provision presents an unusual opportunity to help ensure that our nation's schools and libraries are able to fully participate in the burgeoning Information Age. Based on an analysis designed to catalyze a needed debate on this issue, NTIA has found that the cost of connections as a proportion of total expenditures required to permit schools and libraries to become active partners in the NII appears to be moderately low. Concomitantly, the demands that would be placed on the universal service fund in recovering the discounted portion of connections costs for these institutions would not be extreme, as feared by some.